The El Trébol Landfill Landfill Gas Pre-Feasibility Study: Pump Test Construction, Monitoring and Data Collection

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LANDFILL METHANE OUTREACH PROGRAM

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Presentation Topics

- Project overview
- Objectives of pump test program
- Pump test elements and equipment
- Pump test construction
- Pump test monitoring activities
- Summary of data collected
- Interpretation of pump test results

Project Overview

- **Objectives of Landfill Gas Feasibility Study and Pump Test:**
  - Assess the technical and economic feasibility of the development of an LFG control and utilization project at the El Trébol Landfill.
  - Quantify the potential greenhouse gas (GHG) emissions reduction from implementing a project.
  - Provide a tool to assist potential project developers in making informed decisions regarding additional investigations or moving forward with a project at the landfill.

Objectives of the Pump Test Program

- To measure vacuum (pressure) and flow relationships while actively extracting LFG from the landfill.
- To measure sustainable methane levels of the extracted LFG during the pump test.
- To measure vacuum (pressure) in probes to estimate the lateral vacuum influence of the active pump test.
- To measure oxygen levels of the extracted biogas during the pump test to check for air infiltration through the landfill cover soil during pump test.
- Utilize the results of the pump test to refine the projections of landfill gas recovery.

Pump Test Elements and Equipment

- **3 extraction wells installed in triangle pattern ~150-200 ft apart:**
  - Well 1 – 75 ft (23 m) deep
  - Well 2 – 100 ft (30 m) deep
  - Well 3 – 100 ft (30 m) deep
- **9 shallow (2 m) monitoring probes – 3 around each well**
  - Probes A, B, and C at 5m, 15m, and 25m distance from each well

Pump Test Elements and Equipment (cont.)

- **An electrically-powered mechanical blower to exert a vacuum on the extraction wells and withdrawal LFG from the wells.**
  - The blower was powered on-site by a portable diesel powered electrical generator.

Pump Test Elements and Equipment (cont.)

- **Interconnection of the three extraction wells and the blower with solid piping.**
  - Flow control valves were installed at each extraction well and the blower inlet to allow adjustment of vacuum and flow both system-wide and at individual wells.

Pump Test Elements and Equipment (cont.)

- **Gas testing, and flow and pressure monitoring equipment.**
  - Gas quality (methane, oxygen) and static pressure measurements were taking using a Landtec GEM 500 Infrared Gas Analyzer (GEM 500).
  - Gas flow measurements were taken using an Accu-Flow meter and the GEM 500.

Pump Test Construction

- **Landfill overview**

Pump Test Construction (cont.)

- **Disposal operations**

Pump Test Construction

- **Extraction well construction**

Pump Test Construction (cont.)

- **Problems with liquids in extraction wells**

Pump Test Construction (cont.)

- **Piping and blower**

Pump Test Monitoring Activities

- Measured methane %, oxygen %, CO_2%, balance gas %, vacuum, and LFG flow at wells
- Measured methane %, oxygen %, CO_2%, balance gas %, and vacuum in monitoring probes
- Measured static conditions on July 26
- Measured active conditions July 29 – August 9 (2 – 4 times per day)

Pump Test Monitoring Activities (cont.)

- **Passive conditions**
  - Measurements before blower turned on and vacuum applied for baseline conditions
  - Extraction well data:
    - Good gas quality - high methane (>50%) and low oxygen in Wells 1 and 3;
    - Low gas quality in Well 2
  - Monitoring probe data: methane >37% in 8 of 9 probes shows presence of landfill gas near landfill surface

Pump Test Monitoring Activities (cont.)

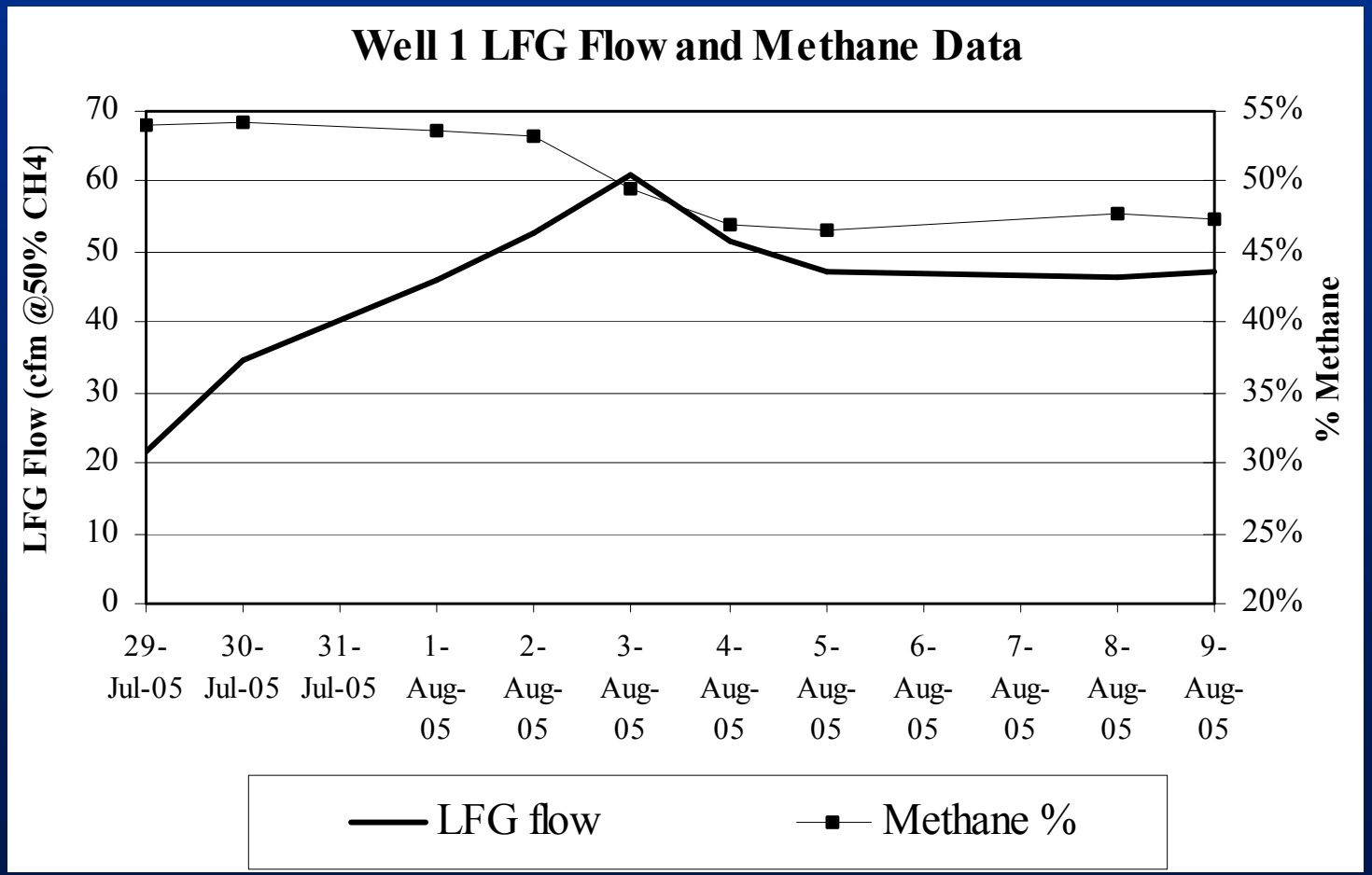
- **Active conditions – blower turned on & vacuum applied**
  - Extraction well data
    - Well 1: Good gas quality (average 50% methane), vacuum, and flow rates
    - Well 2: Fairly poor gas quality (average 28% methane) and no flow
    - Well 3: High gas quality (average 58% methane), but little or no flow
  - Monitoring probe data: No vacuum observed in any of the 9 probes – no well influence?

Summary of Data Collected

- **Extraction well data – only Well 1 provided good, useable results**
  - Initial high methane levels (54%) declined and stabilized at 47% during second half of test
  - LFG flows increased to a peak of 61 ft^3/minute on Aug. 3, then declined and stabilized at about 48 ft^3/minute during second half of test
  - Stabilization of methane % and flow rates indicates steady-state conditions, where gas extraction rates are ~ equal to generation rates

Summary of Data Collected (cont.)

- **Chart of Well 1 data**

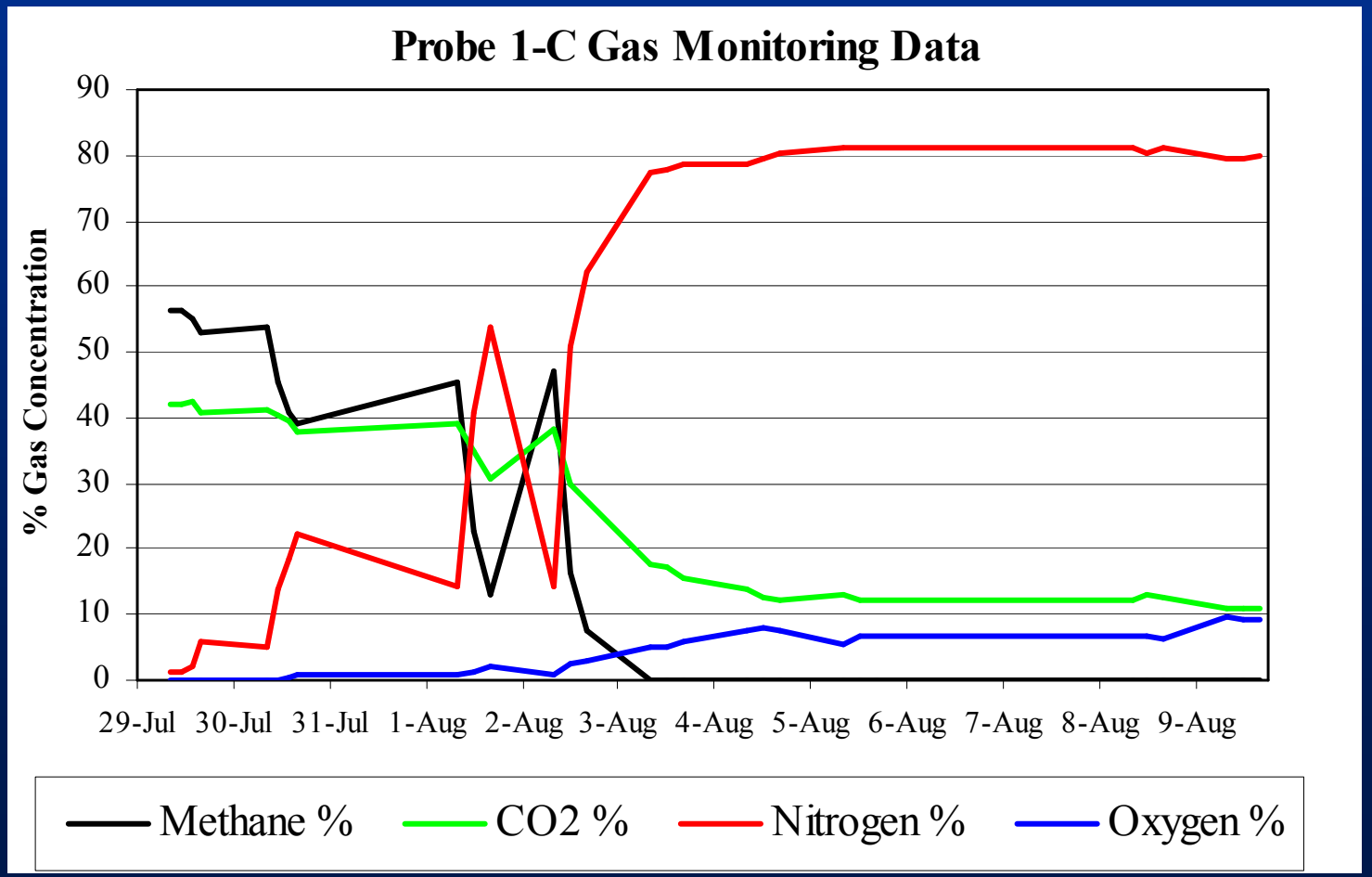


Summary of Data Collected (cont.)

- **Monitoring probe data**
  - No vacuum observed in probes near Wells 2 and 3 since no gas flow established in these wells
  - No vacuum in probes near Well 1, but trends in methane and other gases in outermost probe (at 25m distance) indicate influence
    - Methane declined to 0% by August 3
    - Steady decreases in CO_2 and increases in oxygen and balance gas (nitrogen)
    - Results indicate onset of air intrusion – probe is within the "radius of influence" of Well 1

Summary of Data Collected (cont.)

- **Chart of Probe 1-C data**



Interpretation of Pump Test Results

- **Step 1: Estimate the maximum steady-state LFG flow achieved in the pump test**
  - Equal to the maximum sustained flow at Well 1 without air intrusion.
  - This was estimated to be the average for the August 4-9 period = 48.1 ft^3/minute (81.7 m^3/hr) at 47.1% methane = 45.3 ft^3/minute (77 m^3/hr) at 50% methane

Interpretation of Pump Test Results (cont.)

- **Step 2: Estimate the radius of influence (ROI) of extraction Well 1**
  - ROI > 25 m since Probe 1-C showed evidence of being within influence of Well 1
  - ROI of extraction well in full-scale system is typically 1.25-2.5 well depth
    - Based on high moisture content of waste and presence of liquids, ROI expected to be low end of range = ~1.5 x well depth
  - ROI estimate = 1.5 x 23 m depth = 35 m

Interpretation of Pump Test Results (cont.)

- **Step 3: Estimate the Well 1 unit recovery rate (in ft^3 of LFG per pound of waste)**
  - Step 3a: Calculate volume of waste within influence of Well 1 = 178,312 m^3
  - Step 3b: Estimate refuse density = 1,230 lbs/yd^3
  - Step 3c: Estimate tons of waste within influence = 143,403 tons
  - Step 3d: Calculate annual LFG flow from Well 1 = 23.8 million ft^3/yr
  - Step 3e: Calculate unit recovery rate = 0.083 ft^3/lb-yr

Interpretation of Pump Test Results (cont.)

- **Step 4: Extrapolate Well 1 unit recovery rate to total waste in landfill**
  - Well 1 unit recovery rate (0.083 ft^3/lb-yr) x estimated amount of waste in place and available for LFG recovery (3,756,504 tons) = **1,130 ft^3/minute**
  - This is the estimate to be used for adjusting the LFG model.

Summary and Conclusions

- Pump test successfully demonstrated LFG extraction at one of three wells
- Demonstrated steady-state Well 1 LFG extraction rate of 48.1 ft^3/minute (81.7 m^3/hr) at 47.1% methane
- Results imply potential LFG recovery from the landfill of 1,130 ft^3/minute

Questions?

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